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SUMMARY OF JAPANESE BEETLE PARASITE LIBERATIONS,  
INCLUDING THE YEAR 1940

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The object of this report is to bring together data on releasements of the more important parasites of the Japanese beetle for the benefit of the various State workers who have cooperated in this work and others who may be interested.

Although five parasite species and two racial forms are known to be established, only four of these, namely, Tiphia vernalis Rohw., T. popilliavora Rohw., T. popilliavora (Korean strain), and Centeter cinerea Ald., have received consideration in recent years. The status of Dexia ventralis Ald. and Prosenia sibirita F. remains about the same as recorded at the close of the 1938 season<sup>1/</sup>.

Tiphia vernalis, the spring Tiphia.--This parasite, first released in 1926, is now well established generally throughout the area of intense beetle infestation. Many of the early colony centers have now coalesced so that large areas of continuous distribution of the parasite now occur. As may be expected, the abundance of the parasite is varied over these areas, owing to differences in ecological conditions. However, in areas of short-cropped grass, such as golf courses, pastures, large estates, and cemeteries, which are also most favorable for beetle development, this parasite is often found in such abundance as to be an important controlling factor of the Japanese beetle; in fact this parasite is now more abundant in this country under favorable conditions than it is in its native land under similar conditions. An idea of the abundance of T. vernalis females at some of the older colonies may be obtained from the following data on collections of females for recolonizing purposes (table 1).

<sup>1/</sup>

J. L. King: Colonization of Japanese Beetle Parasites in the Eastern States in 1938. (Insect Pest Survey Bull. V. 19, sup. to No. 1. March 15, 1939).

Table 1.--Collection of *T. vernalis*, females only, at older colonies

Year of collection	: Colonies used for collection	: Collectors, maximum	: Total man-hours spent in actual collecting	: Total females collected
	: <u>Number</u>	: <u>Number</u>	: <u>Number</u>	: <u>Number</u>
1938 -----	: 14	: 11	: 393	: 32,293
1939 -----	: 17	: 13	: 274	: 14,813
1940 -----	: 10	: 8	: 212	: 19,745

The history of one of the oldest colonies of *T. vernalis*, namely, that in the Philmont Country Club area, is also interesting. This colony, started in 1927, is now well within the older area of infestation where beetle abundance has subsided and where the type A milky disease (*Bacillus popilliae*) has long been established and has a high incidence of occurrence. Yet, notwithstanding these factors and reduction by intense annual collections of females for colonization purposes, this colony has produced a total of 63,468 females which have been used in the further distribution of the species, as shown by table 2.

Table 2.--Collection of *T. vernalis* females at the Philmont Country Club (colony released in 1927)

Year of collection	: Females collected
	: <u>Number</u>
1931 -----	: 167
1932 -----	: 4,627
1933 -----	: 5,391
1934 -----	: 8,778
1935 -----	: 8,109
1936 -----	: 1/7,198
1937 -----	: 9,478
1938 -----	: 18,359
1939 -----	: 2/0
1940 -----	: 2/1,361
Total -----	: 63,468

1/ Percentage of parasitization in this area in 1936 was 58.4.

2/ Owing to objections raised by property owners, no collections were made in 1939, and only very limited collections in 1940, although there was no noticeable reduction in the *Tiphia* population observable in either year.

Parasitization of Japanese beetle larvae by *T. vernalis*.—Four surveys have been conducted to determine the effectiveness of *T. vernalis*



as a parasite of Japanese beetle grubs. Owing to the fact that the activities of this parasite are hidden under the soil and soil surveys are necessarily limited in scope, it is believed that the surveys are only an indication of the effectiveness of the species. The great abundance of males and females during the mating flights of this species certainly indicates a greater degree of potential parasitization than these few surveys indicate. The results of the surveys are shown in table 3.

Table 3.—T. vernalis parasitization surveys

Colony site (all in Pennsylvania)	: Year : : of : : survey:	: Area : : dug :	: Average : : grubs per: : sq. ft.:	: Total : : grubs : : recovered:	: Parasitized : grubs
		:Sq. ft.:	: Number	: Number	: Number:Percent
Overbrook Country Club <sup>1/</sup>	1937:	565	0.9	492	179 : 36.4
Rushland <sup>2/</sup> -----	1935:	200	5.7	1,146	702 : 61.3
Do -----	1936:	200	4.9	817	388 : 47.5
Do -----	1939:	200	5.3	1,054	506 : 48.0
Philmont Country Club -:	1936:	200	5.7	1,142	668 : 58.5

1/

The Overbrook colony is considered to be within the older area of infestation, where beetle abundance has subsided, and we believe this has been largely due to grub parasitization by T. vernalis. In the year 1936, prior to this survey, Tiphia was extremely abundant, 7,382 females being taken from this area. At the time of the survey the milky disease type A. incidence was 17 percent.

2/

The Rushland colony is in a pasture approximately on the border of the area of moderate infestation. Only minor collections of Tiphia have been made at this point. The incidence of disease is unknown, but it is believed to be present.

Interrelation of T. vernalis grub parasitization and milky disease.

The active period of parasitization by T. vernalis is from mid-May to about June 20, the Tiphia thus attacking the larval population at its lowest point, after the high disease mortality of the previous summer and fall. If disease is present, its development during the spring period of Tiphia activity is so slow, owing to unfavorable soil temperatures, that it does not compete seriously with T. vernalis. It is true that some overlapping does occur and that Tiphia will oviposit on diseased grubs but, if the disease is not in its final stages, most of the parasites will complete their development, as they are immune to the effects of the organism. Other species of Tiphia which are active during the latter part of the summer and early fall, when soil temperatures are most favorable for disease development, may be reduced in numbers by the death of diseased parasitized hosts.

Colonization of T. vernalis.—A total of 1,422 colonies of this species have now been distributed in 9 States and the District of Columbia. Of these 150 were released in 1940. The New York (Geneva) and

Connecticut Agricultural Experiment Stations cooperated in the distribution of the colonies in their respective States. No colonies were distributed in Maryland in 1940, but 2,500 females (the equivalent of 25 colonies) were collected for the use of authorities of the University of Maryland for use in mass rearing of the species. Table 4 gives a complete summary of all liberations to date, including those of 1940.

Tiphia popilliavora, the summer Tiphia.--This parasite from Japan was first released in 1921. Although it has been extensively colonized throughout the heavily infested area, it has never reached the degree of abundance manifest with the preceding species. It is active from mid-August to about the first week in September. Frequently the parasite suffers reduction through the lack of sufficiently developed host larvae at the time of egg laying. When most of the eggs are laid on second-stage host grubs the developing parasites are predominantly males, the normal sex ratio occurring only when most of the eggs are laid on third-stage host grubs. There are now 709 colonies of this species distributed in 7 States. Because of unfavorable conditions for the collection of this species which have obtained for the last 3 years, no colonization of this species was carried on in 1940. Table 5 gives the present distribution of this species.

Tiphia popilliavora (Korean strain).--This racial form of the species is from Chosen (Korea). It has received more attention in recent years because of its later emergence, being present in the field from late in August to mid-September. The later emergence of this strain has an advantage in that it is better synchronized with the proper stage of its host, overcoming in part the difficulties met with in the type or Japanese strain. After a number of years in the field it has been found to retain the habit of late emergence. There have been 37 colonies of this species released to date and checking in 1940 indicates that at least 40 percent of these releasements have become established. Table 6 shows the distribution of this form.

Tiphia popilliavora (Chinese strain).--In an effort to obtain better synchronization with host, a later emerging Chinese race or strain of T. popilliavora was introduced between 1927 and 1929, 22 colonies comprising 4,130 individuals being released in New Jersey and Pennsylvania. Only 1 feeble establishment was noted in 1929 and again in 1930. The species has not since been recovered.

Centeter cinerea.--This parasite originated in Japan, where it is an important parasite of the adult Japanese beetle. The species has become established in the Eastern States, and in Pennsylvania and New Jersey is found continuously distributed over approximately 500 square miles. Within this area it has not assumed importance in controlling the beetle because it is not well synchronized with its host, by far the greater number of parasites emerging about 2 weeks too early. The habit of early emergence seems to occur even in the most northern and southern limits of distribution. Centeter has been colonized with 25 colonies in 5 States and the District of Columbia. Table 7 shows the present distribution of this parasite.



Dexia ventralis.--This parasite was colonized at intervals between the years 1926 to 1938, during which time 15,254 individual parasites were distributed in 14 colonies. Though 5 States were selected, representing a varied number of habitats, only 1 colony at Haddonfield, N. J., has ever been recovered; this colony seems to sustain itself feebly. The species has 3 broods per year, with the second or summer brood emerging at a time when Japanese beetle larvae are very scarce. It was thought that, as the species is not specific in host selection, it would do well in areas where native Phyllophaga larvae could act as alternate hosts; however, attempts to establish it in such areas have thus far proved unsuccessful. The distribution of releasements by States is as follows: New Jersey, 3; Pennsylvania, 5; Illinois, 4; Maryland, 1; New York, (Long Island), 1.

Prosenia sibirita.--This parasite of Japanese beetle larvae has been released in numbers totaling 12,364 individuals; distributed in varying numbers in 5 releasements between 1923 and 1930. Only 1 colony in the Moorestown, N. J., area is known to be established. No recent colonization of the species has been undertaken. In Japan, its native habitat, the parasite is most numerous in areas where Popillia has a partial 2-year life cycle. The species seems to be of little value in the United States at the present time, although as yet no area in the infested portions of this country has been found where there is definite evidence of 2-year life cycle of the host.



Table 4.--Liberations and recoveries of *Tiphia vernalis*, a Japanese beetle parasite--Continued

State and county	Colonies released in															Recovery of		Total
	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	colonies 3 years old or older	Percentage: recovery of:	
Massachusetts:																		
Hamden							1	1				1				2	1	3
Total							1	1				1				2	50.0	3
New Hampshire:																		
Cheshire												1				1		1
Merrimac											1					1		1
Strafford											1					1	0	1
Total											2	1				3	66.6	3
New Jersey:																		
Atlantic																		
Burlington	1		2	1	1			9			2					23	12	27
Camden		2						6								9		9
Jape May											2							2
Cumberland									5		1					5		6
Houcester										3						10		13
Hunterdon										16	20	2	7			46		61
Mercer							5	24	17	6						23		52
Middlesex							1	1	1	7	5	9				2		24
Monmouth							2	2	10	7						12		19
Ocean							3	3	1							4		4
Salem							2	10	1	5						13		18
Somerset							1	1	5	12	29	11	2			6		66
Union												18				2		18
Morris													1					4
Bergen																		6
Essex																		1
Total	1	2	2	1	1		12	62	49	60	59	40		10	33	132	76	332





Table 5.--Liberations and recoveries of *Tiphia popillivora*, a Japanese beetle parasite

State and county	Colonies released in															Recovery of :		Total
																: colonies 3 years old or older :		
																: colonies recovered of :		
	1921	1922	1925	1927	1928	1929	1930	1931	1934	1935	1936	1937	1938	1939	1940	scouted	in 1940	
Connecticut:																		
Fairfield	--	--	--	--	--	--	--	--	--	--	3	11	--	--	3	3	--	14
New Haven	--	--	--	--	1	--	--	--	--	--	1	3	--	--	2	1	--	5
Hartford	--	--	--	--	--	--	--	--	--	--	1	2	--	--	1	1	--	3
New London	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	1
Windham	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	1
Total	--	--	--	--	1	--	--	--	--	--	5	18	--	--	6	5	83.4	24
Delaware:																		
New Castle	--	--	--	--	--	--	--	4	5	14	8	--	--	--	4	2	--	31
Total	--	--	--	--	--	--	--	4	5	14	8	--	--	--	4	2	50.0	31
Maryland:																		
Cecil	--	--	--	--	--	--	--	--	1	3	--	7	34	--	--	--	--	45
Harford	--	--	--	--	--	--	--	--	--	--	--	24	--	--	--	--	--	24
Kent	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	2
Dorchester	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	1
Somerset	--	--	--	--	--	--	--	--	--	--	--	1	2	--	--	--	--	3
Washington	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	1
Worcester	--	--	--	--	--	--	--	--	--	--	--	1	1	--	--	--	--	2
Prince Georges	--	--	--	--	--	--	--	--	--	--	--	--	3	--	--	--	--	3
Queen Anne	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	1
Caroline	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	1
Wicomico	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	1
Anne Arundel	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	1
Total	--	--	--	--	--	--	--	1	3	--	7	64	10	--	--	--	--	85



Table 5.--Liberations and recoveries of *Tiphia popillia*vara, a Japanese beetle parasite--Continued

State and county	Colonies released in																			Recovery of :		Percentages :	
																				:		:	
	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	Number : colonies : Total	old or older : recovery of :	scouted : in 1940 : scouted : 1921-40
New Jersey:																							
Burlington	2	1	1	4	13	5	5	13	24	1	2	1	5	5	1	1	1	1	1	1	65	32	67
Camden				2	1	2	1	2	1	1	2	1	1	1	1	1	1	1	1	1	8	4	9
Gloucester				1	1	1	1	1	14		1	1	7	7	4	14	1	1	1	1	18	3	23
Hunterdon													4	4	5	1	1	1	1	1	44	17	18
Mercer									1				5	37	2	1	1	1	1	1	5	0	49
Middlesex													3	3	1	1	1	1	1	1	1	1	6
Monmouth													5	5	15	1	1	1	1	1	10	1	1
Salem													3	3	24	2	2	1	1	1	17	5	20
Somerset																					171	63	31
Total	2	1	1	7	25	48	17	40	1	1	2	2	1	1	1	1	1	1	1	1	171	63	224
New York:																							
Nassau				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	0	2
Queens Borough																					1	0	1
Westchester																							30
New York City																							1
Total				1	2	1	2	1	2	1	2	2	1	1	1	1	1	1	1	1	3	0	34
Pennsylvania:																							
Bucks				1	4	5	31	41	22	1	5	8	4	4	4	4	3	1	1	1	91	54	112
Chester						1	15	5													20	10	28
Cumberland							1	1															1
Dauphin							1	1	1												1	0	2
Delaware							38		4	10											52	38	52
Montgomery						13	46	15	7	19											87	56	100
Philadelphia				2				1	9			1	1	1	1	1	1	1	1	1	11	9	13
Total				3	15	18	132	62	61	1	18	13	3	3	3	3	3	3	3	3	262	167	308
Virginia:																							
Chesterfield																							1
Norfolk																							1
Northampton																							1
Total																							3
Grand total	2	1	1	11	33	101	2	43	185	134	44	25	94	33							446	237	709

Table 6.--Liberations and recoveries of *Tiphis popilliavora* Roh. (Korean strain),  
a Japanese beetle parasite

State and county	Colonies released in										Recovery of		Total
	1927	1934	1935	1936	1937	1938	1939	1940	scouted	in 1940	scouted	colonies	
Delaware:	:	:	:	:	:	:	:	:	:	:	:	:	:
New Castle	--	--	--	--	3	--	--	--	3	0	--	--	3
Total	--	--	--	--	3	--	--	--	3	0	00.0	--	3
Maryland:	:	:	:	:	:	:	:	:	:	:	:	:	:
Cecil	--	--	--	--	1	--	--	--	1	0	--	--	1
Total	--	--	--	--	1	--	--	--	1	0	00.0	--	1
New Jersey:	:	:	:	:	:	:	:	:	:	:	:	:	:
Camden	1	1	--	--	--	--	--	--	2	1	--	--	2
Hunterdon	--	--	4	--	--	--	--	--	4	1	--	--	4
Mercer	--	--	1	--	--	--	--	--	1	1	--	--	1
Middlesex	--	--	--	1	--	--	--	--	1	1	--	--	1
Somerset	--	--	--	2	3	--	--	--	5	0	--	--	5
Total	1	1	5	3	3	--	--	--	13	4	30.7	--	13
Pennsylvania:	:	:	:	:	:	:	:	:	:	:	:	:	:
Montgomery	--	--	3	--	--	--	--	--	3	3	--	--	3
Philadelphia	--	--	1	--	--	--	--	--	1	0	--	--	1
Delaware	--	1	--	--	--	--	--	--	1	1	--	--	1
Chester	--	--	--	6	2	7	--	--	8	4	--	--	15
Total	--	1	4	6	2	7	--	--	13	8	61.5	--	20
Grand total	1	2	9	9	9	7	--	--	30	12	40.0	--	37

State and county:	Colonies released in										Recovery of colonies 3 years old or older	Percentage recovery of:	Total		
	1922:	1924:	1928:	1929:	1934:	1935:	1936:	1937:	1938:	1939:	1940:	scouted:	in 1940:	scouted:	1922-40
Connecticut:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Fairfield-----	--	--	1	1	--	--	--	--	--	--	--	1	:	1	--
Hartford-----	--	--	--	--	--	--	--	1	--	--	--	--	:	--	--
Total-----	--	--	1	1	--	--	--	1	--	--	--	1	:	1	100.0
New Jersey:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Burlington-----	--	--	--	2	--	--	--	--	1	--	--	2	:	1	--
Camden-----	1	--	--	--	--	--	--	--	--	--	--	1	:	1	--
Hunterdon-----	--	--	--	--	1	--	--	--	--	--	--	1	:	1	--
Middlesex-----	--	--	--	1	--	--	--	--	--	--	--	1	:	0	--
Total-----	1	--	--	2	2	--	--	--	1	--	--	5	:	3	60.0
Pennsylvania:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Berks-----	--	1	--	--	--	1	--	--	--	--	--	--	:	--	--
Bucks-----	--	1	--	1	1	--	--	--	--	--	--	3	:	2	--
Dauphin-----	--	--	1	3	--	--	--	--	--	--	--	2	:	1	--
Delaware-----	--	--	--	1	--	--	--	--	--	--	--	1	:	0	--
Montgomery-----	--	--	1	1	1	--	--	--	--	--	--	3	:	3	--
York-----	--	--	--	1	--	--	--	--	--	--	--	--	:	--	--
Total-----	--	1	2	7	2	1	--	--	--	--	--	9	:	6	66.6
New Hampshire:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Cheshire-----	--	--	--	--	--	--	1	--	--	--	--	--	:	--	--
Total-----	--	--	--	--	--	--	1	--	--	--	--	--	:	--	--
District of Columbia:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Washington-----	--	--	--	--	--	--	--	--	1	--	--	--	:	--	--
Total-----	--	--	--	--	--	--	--	--	1	--	--	--	:	--	--
Massachusetts:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Berkshire-----	--	--	--	--	--	--	--	--	--	--	1	--	:	--	--
Total-----	--	--	--	--	--	--	--	--	--	--	1	--	:	--	--
Grand total--:	1	1	3	10	4	1	1	1	2	--	1	15	:	10	66.6
															25